



**Access to new markets and the impact of bilateral trade agreements on local
agricultural economies: evidence from the Colombia-South Korea FTA**

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**Trabajo presentado como requisito para optar por el
título de Magíster en Economía**

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Bogotá – Colombia

2025

Access to new markets and the impact of bilateral trade agreements on local agricultural economies: evidence from the Colombia-South Korea FTA ^{*}

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June 2025

Abstract

Access to previously closed international markets might benefit producers in an economy with comparative advantage in the liberalized sectors. This paper aims to estimate the impact of bilateral trade agreements between countries with complementary production structures on local agricultural supply. Using data from the municipalities of Colombia in 2011-2021, I employ a difference-in-differences strategy to explore the average effects on the value of agricultural production and short-term economic growth of the Colombia-South Korea Free Trade Agreement (CKFTA). I calculate exposure to the South Korean tariff reductions at the municipality level by exploiting variation in pre-treatment production intensity. I find positive effects on production and higher crop concentration for the most exposed municipalities, but no statistically significant effects on income patterns. Additional findings suggest that the municipalities with higher market and credit access drive these positive effects on production.

Keywords— agriculture, FTA, local effects, liberalization, bilateral trade.

^{*}This paper was enriched by comments from Santiago Saavedra, Paul Rodriguez, Mateo Uribe Castro, Umberto Muratori, Lilian Guio Navas, Santiago Fernández, Laura Clavijo, Sebastián Cuellar, and participants at Applied Microeconomics Workshop at Universidad del Rosario.

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1 Introduction

The importance of international trade has always been central to economic debates, mainly concerning policy issues in developing countries. A large amount of literature argues that trade liberalization has positive aggregate effects on the economy, however, its distributional effects on welfare are still ambiguous, given the existence of winners and losers (Carroll & Hur, 2020). In particular, bilateral trade agreements have become important mechanisms for seeking opportunities beyond domestic markets. Even in the context of multilateral trade, this type of agreement becomes attractive for governments in the presence of asymmetric factor endowment levels between the signing countries (Saggi & Yildiz, 2010).

This study focuses on the 2016 Free Trade Agreement between Colombia and South Korea (CKFTA). Given differences in endowments and productivity, these countries have complementary export and import baskets. South Korean exports consist mainly of technology-intensive products, while Colombia exports commodities from the primary sector (SNU, 2009). From the agricultural sector perspective, it is not a matter of price competition in the local economy but exploiting opportunities in foreign markets. Indeed, the FTA targets 99% of the Colombian agricultural supply that was highly protected in the South Korean market.

Regarding the Colombian context, agricultural activities represent between 6% and 8% of Colombia's GDP, providing 15% of total employment (Finagro, 2023). Likewise, according to the Ministry of Agriculture, in 2016, 70% of the food was produced by small farmers, meaning that this sector plays an important role in promoting economic development and population well-being. Therefore, evaluating the effectiveness of trade policies targeting agriculture remains relevant today, particularly in terms of productivity, income growth, and distribution in rural economies.

This study seeks to quantify the short-term effects of the FTA between Colombia and South Korea on agricultural supply and income growth patterns of Colombian municipalities. I measure GDP at the municipality level between 2011 and 2021 using nightlights and value-added estimates. Prior, the effect of the CKFTA on the local economic dynamics is ambiguous. On the one hand, trade could potentially increase income and improve productivity through higher demand and the adoption of new technologies. On the other hand, internal barriers might slow down export production and investment in the agricultural sector. Historically, Colombian roads have been precarious (Alvear Sanín, 2008), especially in rural areas, restricting market access and regional integration. Consequently, the CKFTA framework is a case study that allows a better understanding of the relationship between

international trade and rural development.

The implementation of this study presents two main methodological challenges. The first consists of measuring economic activity at the municipality level. The literature has shown that satellite imagery becomes a useful tool to measure economic activity at relatively small spatial units when lacking a reliable measure (Yeh et al., 2020; Khachiyan et al., 2021). Particularly, there is evidence from Colombia that the use of night-time lights is a valuable method to estimate patterns of socioeconomic change at the municipality level (Pérez-Sindín et al., 2021). Hence, I use official sources and satellite data to compare and complement the findings on economic activity.

The second challenge deals with consistently mapping the exposure level that each municipality's agricultural production faces under the CKFTA framework. Since the tariff is the same regardless of the producer's location, I construct exposure to the CKFTA at the municipality level, based on nominal tariff reductions weighted by crop-specific shares. In this sense, I attempt to capture the degree to which local agricultural production was likely affected by the CKFTA, generating variation in the degree of potential exposure across municipalities. I exploit this variation to estimate causal effects, defining the treated and control municipalities as those that lie above and below the median of the exposure measure distribution, respectively. Specifically, I employ two complementary estimation approaches. The first consists of a canonical difference-in-differences strategy, whereas the second relies on implementing synthetic control methods to provide more robust estimates towards satisfying the parallel trend assumption.

This paper finds that the most exposed municipalities experienced an average increase in agricultural production of 7.5%, but the effect is not significant until 3 years after implementation. In addition, there is evidence of higher crop concentration since 2017 that can be interpreted as a signal of preparation for the FTA tariff reductions. Nevertheless, these effects are small compared to the mean of the control municipalities. Likewise, these results are robust regardless of the threshold used to define treatment status. Furthermore, there is no evidence for short-run local economic growth. In the synthetic difference-in-differences specification, value-added and night-time lights yield contrary conclusions, and hence, no clear effect is detected. In addition, when analyzing heterogeneous responses due to municipal pre-treatment characteristics, the effects on agricultural supply are driven by municipalities with higher domestic market proximity and more credit granted.

The study relates to the literature on trade dynamics in rural economies. A piece of litera-

ture studies the determinants of agricultural productivity regarding the expansion of trade beyond local markets. [Gáfaro and Pellegrina \(2022\)](#) showed that removing participation barriers to non-local markets increases farm productivity, thus agricultural value added. This might suggest that when favorable conditions arise, income in rural municipalities can significantly improve, fostering economic growth and reducing poverty. Now, when expanding to international markets, the literature has found that the reduction of relative prices and factor immobility play a fundamental role in explaining the distributional effects of international trade ([Nicita, 2004](#); [Marchand, 2012](#); [Ojeyinka & Adegboye, 2017](#); [Autor et al., 2013](#)). However, these studies tend to focus on multilateral trade or traditional trade partners. For example, [Topalova \(2010\)](#) found that the liberalization of Indian trade in the 1990s experienced slower poverty reduction and lower consumption in the most exposed rural districts. Particularly in the agricultural sector, [Cuesta et al. \(2015\)](#) concluded that trade liberalization in Chile had a long-term increase in agricultural output through higher total factor productivity. It is worth noting that trade not only produces direct effects on agricultural production of local economies but might also generate unexpected impacts on allocation decisions regarding, for example, illegal markets ([Ladino, 2021](#)).

Nevertheless, research has focused mainly on the effects of import competition on trade liberalization episodes, not on income growth due to export incentives in the most exposed sectors. Following this line, the contribution of this research relies on two key aspects: (i) Understand the local economic responses to foreign market opportunities under a trade framework between countries with complementary productive structures and (ii) open a discussion about the interventions that local governments can implement to exploit the advantages of trade policies and maximize their potential benefits, even under bilateral trade with a non-traditional trade partner.

The rest of the paper is organized as follows: Section 2 presents a description of Colombia's FTA with South Korea. Section 3 describes the data. Section 4 discusses the empirical strategy. Section 5 presents the main results, heterogeneous effects, and robustness checks. Section 6 presents policy implications. And section 7 concludes.

2 Colombia under the FTA with South Korea

The FTA Colombia-South Korea began with negotiations in 2009, was signed in February 2013, was approved by the Colombian Congress in December 2014, and entered into force

in July 2016. For Colombia, it is the first FTA implemented with an Asian-Pacific country. According to Law 1747 of December 26, 2014 ([Congreso de la república de Colombia, 2014](#)), the agreement covers several objectives that can be summarized as follows: (i) Target markets previously closed to Colombian products, (ii) create new jobs and increase cooperation in strategic sectors, (iii) take advantage of the South Korean demand and its growing importance in the international spectrum and (iv) increase foreign direct investment in productive sectors.

According to the 2021 report of the current FTA that follows from Law 1868 of 2017 ([MinComercio, 2021](#)), there are several metrics regarding the use of these agreements from a macroeconomic point of view. These metrics include the number of new firms and the export growth of new and old non-mining-energy products (NME). For the FTA with South Korea, the number of tariff subheadings with export values greater than 10,000 USD increased by 17.2% in 2021 compared to 2015. In addition, the total value of new NME products was 26.3 million USD up to 2021, and the old NME products grew by 117 million USD compared to 2015. Moreover, the number of exporter firms increased by 27.4%.

Table 1: Most protected products

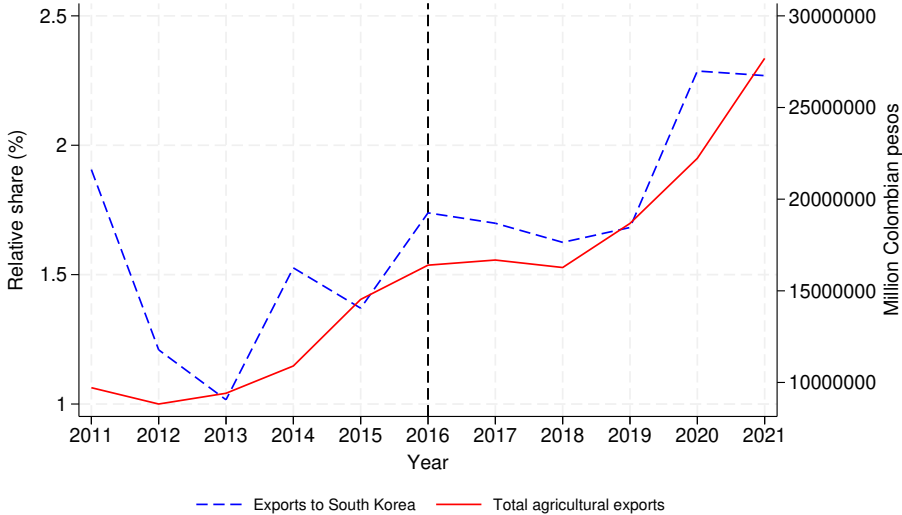
| Product | Ad Valorem Tariff | | | |
|---|-------------------|--------|--------|--------|
| | 2015 | 2020 | 2025 | 2030 |
| Milling products | 313.10 | 245.86 | 179.45 | 113.63 |
| Cereals | 207.22 | 172.51 | 105.09 | 57.35 |
| Legumes and vegetables | 107.88 | 61.85 | 32.64 | 21.95 |
| Gums, resins, and other juices | 92.59 | 70.98 | 68.82 | 68.77 |
| Oilseed and oleaginous fruits | 68.71 | 59.93 | 58.68 | 58.09 |
| Albuminoid materials | 63.78 | 40.18 | 21.35 | 3.55 |
| Milk and dairy products | 54.79 | 33.01 | 22.48 | 17.58 |
| Edible fruits | 40.10 | 23.12 | 12.52 | 10.05 |
| Coffee, tea, yerba mate, mate, and spices | 39.62 | 17.24 | 8.75 | 1.46 |
| Miscellaneous food preparations | 35.01 | 25.01 | 21.38 | 21.02 |

Notes: Data on tariffs comes from the South Korea Tariff Reduction Schedule. Product aggregation corresponds to the duty chapter of the Harmonized System of International Trade. The table presents the ten duty chapters with the highest baseline tariffs.

In the agricultural sector, the CKFTA provides preferential conditions to products highly protected in the Korean market like cereals, vegetables and fruits, as shown in Table 1. However, the timeframe for elimination varies according to the product and the base tariff, therefore, products with higher pre-FTA tariffs tend to have a slower rate of elimination.

Regarding specific products, coffee varies between 0 and 3 years; flowers between 3 and 5 years; banana and plantains in 5 years; vegetables between 5, 7 and 10 years; tobacco in 10 years; Bovine meat and offal in 19 years; pork between 10 and 16 years; aviculture between 10, 12 and 16 years; and dairy products between 10 and 16 year (Procolombia, 2016). Likewise, the agreement is not limited to tariff reductions but includes channels of privileged treatment in terms of sanitary and phytosanitary requirements to guarantee effective access.

Figure 1: Colombian agricultural exports



Notes: Own calculation based on DANE’s microdata on export flows. The dashed blue line corresponds to the share of Colombian agricultural exports in million FOB pesos to South Korea over total agricultural exports. The red line shows the evolution of total agricultural exports of Colombia in million COP. The dashed vertical line indicates the year in which the CKFTA entered into force. The products belong to the duty chapters: 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 18, and 20, accordingly to the WTO classification.

Regarding agricultural exports, Figure 1 shows that the share of exports to South Korea has its peak in 2020 of approximately 2.5%, which coincides with the complete tariff elimination of many fruits, vegetables, and flowers. Since total agricultural exports increased in 2020, export displacement from other countries to South Korea does not appear to be the case, implying that production must have increased to satisfy Korean demand. When analyzing the evolution of exports from Figure A.5, there seems to be a transition period in both nominal value and volume in the first three years of the agreement. Exports appear to be readjusting to the FTA framework. From 2015 and 2021, agricultural exports to South Korea

recorded an annual growth rate of 14%. Among the most important products, coffee and flowers experienced an export average increase of 12% and 19%, respectively. In the case of bananas and plantains, from non-exporting by 2015, their exports rose to 15.5 million USD in 2021 (MinComercio, 2021). Other products that entered the South Korean market for the first time were mainly fruits, including mango, mangosteen, dried fruits, pitahaya, avocado, and pineapples.

3 Data

This paper focuses on studying the effect of the CKFTA on local agricultural economies, which in this case refer to Colombian municipalities. Specifically, I measure agricultural production, economic growth, the level of liberalization, and some additional municipal characteristics. When merging all sources of information, I end up with balanced panel data for 1068 municipalities in the 2011-2021 period.

3.1 Treatment: CKFTA exposure measure

Based on Topalova (2010) and Dix-Carneiro and Kovak (2023), I create the following weighted tariff average as a measure of exposure toward changes in the protection level of South Korea regarding Colombian agricultural products:

$$TariffReduc_m = \sum_{k=1}^K \bar{\mu}_{mk} \cdot (\tau_k^{preFTA} - \tau_k^{postFTA}) \quad (1)$$

Where $\bar{\mu}_{m,k}$ refers to the share of product k of the total agricultural production¹ value of the municipality m between 2007 and 2014. K is equal to 44, referring to the number of crops with completed tariff elimination in the 2016-2022 period (see Table A.1). In other words, equation 1 includes products with a timeframe for elimination up to 7 years to avoid not yet liberalized products, that is, crops with high pre-FTA tariffs that for the studied period the nominal value is not close to zero. $\tau_k^{preFTA} - \tau_k^{postFTA}$ is the average nominal tariff reduction of crop k taken from Annex 2.A of the Tariff Schedule of Korea.

For a better understanding of the logic behind the exposure level calculation, consider the following set of products in municipalities A and B:

¹Agricultural production data comes from EVA. See section 3.2

Table 2: Example of the exposure approach

| k | Crop | τ_k^{preFTA} | $-\tau_k^{postFTA}$ | $\bar{\mu}_k$ of A | $\bar{\mu}_k$ of B |
|--------------------------|---------|-------------------|---------------------|--------------------|--------------------|
| 1 | Coffee | | 5 | 20% | 0% |
| 2 | Banana | | 30 | 50% | 5% |
| 3 | Flowers | | 20 | 10% | 5% |
| 4 | Avocado | | 25 | 20% | 10% |
| 5 | Rice | | 0 | 0% | 80% |
| | | | | A | B |
| TariffReduc _m | | | | 23 | 5 |

As shown in the Table 2, given the relative importance of each liberalized product, municipality A is potentially more exposed to the FTA since it faces a higher combined tariff reduction.

3.2 Agricultural supply

To understand the dynamics of agricultural markets at the municipality level from the supply side, I use three variables: land utilization, crop diversification, and value of production. To measure them, I use the available data on planted area and production in tons of the set of crops reported in the *Evaluaciones Agropecuarias* (EVA). These data come from two sources, the 2007-2018 panel from the *Ministry of Agriculture* (MADR) and the 2019-2023 panel from the *Rural Agricultural Planning Unit* (UPRA). Overall, the EVA includes information for approximately 200 different crops.

$$AP_{mt} = \sum_{j=1}^{J_{mt}} Kg_j^{mt} \cdot P_j^{2014} \quad (2)$$

Following equation 2, I calculate the value of production using the 2014 prices for agricultural products in Colombian pesos per kilogram from the *Agricultural price and provision system* (SIPSA) of the *National Department of Statistics* (DANE) for the set J_{mt} of crops produced in each municipality in year t . For products in the EVA that are not reported in the SIPSA, I use the *Information System on Producer Prices of the Food and Agriculture Organization* (FAO). For the remaining crops without price data in either source, I use the mean price of

the respective crop group according to EVA classification.

$$CD_{mt} = 1 - \sum_{j=1}^{J_{mt}} \alpha_{jmt}^2 \quad (3)$$

To analyze municipal crop selection, I use a Herfindahl-Hirschman Index (HHI), which is a common measure in papers concerning crop diversification (Wang et al., 2025; Fujimoto & Suzuki, 2025). The objective is to determine the yearly concentration of agricultural activity in municipality m given the set of products J . In equation 3, α_{jmt} is the specific area share of crop j . I also use the normalized version that accounts for the number of crops in each municipality-year².

3.3 Economic growth proxies

To capture income differences across local economies, I use two sources of information. The first consists of the primary sector value-added reported annually by DANE, defined as the gross production value minus the value of intermediate consumption³. The second approach relies on night-time light data as a proxy of overall economic activity at the municipality level. Using both datasets helps to provide some robustness to the findings regarding the short-term economic growth patterns after the FTA implementation.

The municipal value-added estimates are a statistical effort led by DANE to provide key information for economic regional planning. These calculations, available since 2011, come from the departmental Gross Domestic Product of the National Accounts and are based on secondary information obtained from ministries, government entities, trade associations, organizations, and federations that provide information on each municipality. Figure A.6 shows that this measure is positively correlated with the agricultural production value as defined in equation 2.

In addition, when reliable economic activity measures at a local level are lacking, night lights allow for an increase in the scope of analysis and prediction of economic growth.

²This version satisfies the following transformation of the classical HHI: $\frac{(\sum_{j=1}^{J_{mt}} \alpha_{jmt}^2) - \frac{1}{J_{mt}}}{1 - \frac{1}{J_{mt}}}$

³The primary sector includes agriculture, aviculture, hunting, fishing, livestock, mining, and extractive activities.

(Henderson et al., 2012) showed that night lights are a good fit in capturing real GDP in areas with poor national accounts, not only at the country level, but at subnational disaggregation as well. However, there is no consensus on whether night-time lights truly identify economic patterns in rural areas. In that matter, Pérez-Sindín et al. (2021) provided evidence for Colombia in which night lights can be a valuable method to estimate patterns of socioeconomic change at the municipality, even in areas with less than 5000 inhabitants. For my empirical analysis, I use the harmonized database by Li et al. (2020) to account for a consistent and comparable time series of the period 2011-2021 from the Defense Meteorological Satellite Program (DMSP) and the Visible Infrared Imaging Radiometer Suite (VIIRS) sources.

3.4 Municipal characteristics

To control for potential cofounders and explore heterogeneous effects, I use data on socioeconomic variables measured before the CKFTA implementation such as rural poverty based on the multidimensional poverty index, rural population, credit access measured as the number of credits granted in a municipality, and market access measured as the distance from the municipality to the nearest agricultural market. The previous data are obtained from the Municipal Panel of *Center for Studies on Economic Development* (CEDE) of Universidad de Los Andes.

4 Empirical Strategy

To estimate the causal effect of the FTA on local production and short-term economic growth, I employ a difference-in-differences strategy with two specifications: (i) the canonical regression with dichotomic treatment; and (ii) weighted regression combining synthetic control methods. The first approach seeks to follow the traditional method of estimation used in this type of empirical work, while the second introduces new methods to provide more robustness to the results and test the sensitivity across the methods.

For the first approach, the main equation is the following:

$$Y_{m dt} = \delta_m + \delta_{dt} + \beta(\text{expo}_m \times \text{post}_t) + \sum_{c \in X_m} \phi_c(c \times \delta_t) + \varepsilon_{m dt} \quad (4)$$

Where m , d , and t refer to the municipality, department, and time level, respectively. $Y_{m dt}$ alludes to the agricultural supply variables and economic growth proxies. δ_m are municipality fixed effects to capture differences between municipalities that do not change over time. δ_{dt} are department-time fixed effects to capture weather and other shocks within a specific department. I also run a less saturated model with just year fixed effects (that is, δ_t instead of δ_{dt}). $post_t$ is a dummy that takes the value of 1 after 2015 and 0 otherwise. $expo_m$ is a dummy that identifies the most exposed municipalities, defined as having a weighted average tariff reduction above the median of the distribution. X_m is a set of pre-treatment controls of municipality m which includes the share of rural population, poverty, and the number of pre-treatment crops. These covariates are selected as they might simultaneously explain the municipal level of exposure and its agricultural supply/economic growth trends. ε_t are standard errors clustered at the municipality level. Lastly, β is the parameter of interest which captures the differential change in the outcomes for the most exposed municipalities due to the CKFTA implementation.

To interpret the estimates of equation 4 as causal effects, the main identifying assumption is the parallel trends between treatment and comparison groups. In this case, it means that in the absence of the FTA tariff reductions, agricultural supply variables and overall economic activity between the most exposed and the least exposed municipalities should have evolved similarly. To determine whether this assumption holds, I use equation 5 and test the significance of the coefficients before 2015.

$$Y_{m dt} = \delta_m + \delta_{dt} + \sum_{i \in T \setminus 2015} \beta_i (expo_m \times \delta_i) + \sum_{c \in X_m} \phi_c (c \times \delta_t) + \varepsilon_{m dt} \quad (5)$$

Moreover, to find more comparable control and treatment municipalities due to unobservable characteristics, I use the synthetic difference-in-differences estimator based on equation 4, but with a less saturated model, that is, without department-year fixed effects. This method provides robust estimates and helps to adjust for the parallel trends before treatment (Arkhangelsky et al., 2021). To accomplish that, the estimation consists of weights at the unit and time levels. The unit weights are selected to match pretreatment trends of control municipalities with those for the treated, and time weights help to balance pre- and post-CKFTA periods for the control municipalities. I also include pre-treatment covariates

in calculating the synthetic counterfactual. Figure A.9 displays the geographical distribution of the unit-specific weights for the control municipalities, and to test the improvements of the synthetic diff-in-diff, I compare the evolution of the main outcomes before and after the weights are included.

5 Results

In this section, I discuss the findings from the two methodological approaches presented in the previous section, explore some heterogeneous effects based on municipal characteristics, and provide robustness to enforce the findings. The main result is that there seems to be evidence for a differential increase in agricultural production for the most exposed municipalities, accordingly with standard trade theory, but this effect is small compared to the mean of the control municipalities. Likewise, nothing can be said about a conclusive effect on short-term economic growth, since the value-added estimates and the night-time lights seem to be more sensitive to the estimation method.

5.1 Canonical difference in differences approach

Panel A of Table 3 presents the results of estimating equation 4. There is no differential change in agricultural supply or economic growth in the most exposed municipalities. In Panel B, when including just municipality and year fixed effects, results are similar for the supply variables, with no statistically significant effects. However, when comparing coefficients of column (4), night-time lights seem to be sensitive to the fixed effects specification, but still, the coefficient is not statistically significant.

Table 3: Canonical difference-in-differences

| Outcome | Agric Output (1) | Crop Div (2) | Planted Area (3) | Value Added (4) | Night-time Lights (5) |
|--|---------------------|-------------------|---------------------|--------------------|--------------------------|
| Panel A: Municipality and department-year fixed effects | | | | | |
| Treated \times After CKFTA | 0.062 (0.038) | -0.008 (0.006) | 0.003 (0.026) | 0.025 (0.033) | -0.007 (0.015) |
| Munis Analyzed | 1067 | 1067 | 1067 | 1067 | 1067 |
| Treated Munis | 530 | 530 | 530 | 530 | 530 |
| Obs | 11737 | 11737 | 11737 | 11737 | 11737 |
| Panel B: Municipality and year fixed effects | | | | | |
| Treated \times After CKFTA | 0.040 (0.031) | -0.008 (0.006) | 0.008 (0.023) | 0.023 (0.030) | 0.002 (0.014) |
| Munis Analyzed | 1068 | 1068 | 1068 | 1068 | 1068 |
| Treated Munis | 531 | 531 | 531 | 531 | 531 |
| Obs | 11748 | 11748 | 11748 | 11748 | 11748 |
| R^2 . <i>Adjust</i> | 0.89 | 0.85 | 0.94 | 0.92 | 0.95 |
| Mean(Depvar) Control | 24.35 | 0.58 | 7.87 | 3.54 | 1.76 |
| sd(Depvar) Control | 1.43 | 0.21 | 1.25 | 1.28 | 0.81 |

Notes: Dependent variables of columns (1), (3), (4), (5) are in logarithmic units. All regressions include pre-treatment covariates as explained in section 4. Standard errors are clustered at the municipality level. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

Table 4 depicts the results of equation 4, differentiating two periods: the first 3 years of the agreement and after 2019. For agricultural production in column (1), the sign of the coefficient is the same, but greater for the second period. For crop diversification⁴ results are similar, but after 2019 the coefficient becomes significant. Nevertheless, the coefficients corresponding to planted area, the value-added, and night-time lights are not consistent with the sign of the coefficients.

⁴Results are similar when using the normalized version. See Table A.4

Table 4: By period regressions

| Outcome | Agric Output (1) | Crop Div (2) | Planted Area (3) | Value Added (4) | Night-time Lights (5) |
|--|---------------------|---------------------|---------------------|--------------------|--------------------------|
| Treated \times Between 2016 and 2018 | 0.051 (0.036) | -0.001 (0.006) | 0.014 (0.024) | -0.010 (0.031) | 0.005 (0.016) |
| Treated \times After 2019 | 0.072 (0.044) | -0.016** (0.008) | -0.008 (0.031) | 0.061 (0.040) | -0.018 (0.015) |
| Munis Analyzed | 1067 | 1067 | 1067 | 1067 | 1067 |
| Treated Munis | 530 | 530 | 530 | 530 | 530 |
| Obs | 11737 | 11737 | 11737 | 11737 | 11737 |
| R^2 . <i>Adjust</i> | 0.89 | 0.85 | 0.94 | 0.92 | 0.95 |
| Mean(Depvar) Control | 24.35 | 0.58 | 7.87 | 3.54 | 1.76 |
| sd(Depvar) Control | 1.43 | 0.21 | 1.25 | 1.28 | 0.81 |

Notes: Dependent variables of columns (1), (3), (4), (5) are in logarithmic units. All regressions include municipality fixed effects, department-year fixed effects and pre-treatment covariates as explained in section 4. Standard errors clustered at the municipality level. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

5.2 Continuous treatment

To test the sensitivity of the median split for the exposure level, I estimate a TWFE regression similar to equation 4 but with the weighted tariff (defined in equation 1) as treatment. Table 5 shows that the sign of the coefficients for all dependent variables is the same compared to the canonical diff-in-diff specification. These results suggest that the correlation between FTA tariff reduction and agricultural supply is the same regardless of the approach.

Table 5: Continuous Treatment

| Outcome | Agric Output (1) | Crop Div (2) | Planted Area (3) | Value Added (4) | Night-time Lights (5) |
|--------------------------------------|---------------------|----------------------|---------------------|--------------------|--------------------------|
| Weighted tariff \times After CKFTA | 0.009** (0.004) | -0.00008 (0.0006) | 0.0012 (0.003) | 0.008** (0.003) | -0.0007 (0.001) |
| Munis Analyzed | 1067 | 1067 | 1067 | 1067 | 1067 |
| Treated Munis | 530 | 530 | 530 | 530 | 530 |
| Obs | 11737 | 11737 | 11737 | 11737 | 11737 |
| R^2 . <i>Adjust</i> | 0.89 | 0.85 | 0.94 | 0.92 | 0.95 |
| Mean(Depvar) Control | 24.35 | 0.58 | 7.87 | 3.54 | 1.76 |
| sd(Depvar) Control | 1.43 | 0.21 | 1.25 | 1.28 | 0.81 |

Notes: This regression table shows the results using the weighted average tariff reduction as treatment. Dependent variables of columns (1) and (3) are in logarithmic units. All regressions include

municipality fixed effects, department-year fixed effects, and pre-treatment covariates as explained in section 4. Standard errors clustered at the municipality level. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

Regarding the validity of the canonical diff-in-diff approach Figure A.1 shows the results when estimating equation 5 shows evidence that the parallel trends condition holds for agricultural production, planted area, and economic growth proxies, but not for crop diversification. In addition, since there is not much variation within some departments as depicted in Figure A.4, thus, the department-year fixed effects might drop variance for certain treated municipalities. In that sense, estimates in Table 3 are not necessarily causal effects, just correlation parameters. Therefore, it is convenient to use synthetic control methods so that the municipalities in both groups are comparable and parallel trends are adjusted, thus eliminating undesirable noise of the estimation.

5.3 Synthetic difference-in-differences approach

Table 6 shows the average treatment effect on the most exposed municipalities from the synthetic diff-in-diff regressions. Regarding the agricultural supply, results are consistent in sign compared to the canonical diff-in-diff approach of Table 3. According to column (1), there is an average increase of approximately 7.5% of agricultural production in the most exposed municipalities; however, it represents an increase of barely 0.3% compared to the mean of the control municipalities. Column (2) shows a decrease in crop diversification, which might suggest that most exposed municipalities are focusing production on the liberalized crops. On the contrary, according to column (3), there is no differential change in land utilization. Moreover, respecting the economic growth proxies columns (4) and (5), it is not conclusive whether the FTA had short-term impacts. The coefficient corresponding to the value-added variable is not significant. In contrast, it appears to be an average increase of 2% in night light intensity for the most exposed municipalities.

In addition, Table A.5 shows that the effect on agricultural production is not immediate but starts to be significant in 2020 and 2021, when the tariff of a substantial number of the analyzed crops went down to zero. These results are reasonable when bearing in mind that South Korea is not a traditional partner and therefore adaptation is necessary. Column (2) shows that the decrease in crop diversification begins in 2017, while column (3) indicates that the differential patterns in night light intensity start immediately in 2016.

Table 6: Synthetic difference-in-differences estimates

| Outcome | Agric Output (1) | Crop Div (2) | Planted Area (3) | Value Added (4) | Night-time Lights (5) |
|------------------------------|---------------------|----------------------|---------------------|--------------------|--------------------------|
| Treated \times After CKFTA | 0.072** (0.036) | -0.016*** (0.006) | 0.030 (0.022) | -0.004 (0.024) | 0.019*** (0.007) |
| Munis Analyzed | 1068 | 1068 | 1068 | 1068 | 1068 |
| Treated Munis | 531 | 531 | 531 | 531 | 531 |
| Mean(Depvar) Control | 24.35 | 0.58 | 7.87 | 3.54 | 1.76 |
| sd(Depvar) Control | 1.43 | 0.21 | 1.25 | 1.28 | 0.81 |

Notes: This table reports the Average Treatment Effect on the most exposed municipalities. Dependent variables of columns (1), (3), (4), (5) are in logarithmic units. Standard errors are calculated by bootstrap and clustered at the municipality level. All regressions include pre-FTA covariates. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

Figure A.8 shows the weighted time series of both agricultural supply and economic growth outcomes. Compared to the time series of the standard diff-in-diff regression (see A.7), one can depict that parallel trends improve not only in matching the pre-trends of the treated municipalities, but even closer in value, highlighting the cases of planted area and crop diversification. From those figures, it is also evident that even though there are effects on agricultural supply and night lights, those effects seem small in magnitude relative to the control municipalities.

5.4 Heterogeneous effects on agricultural supply

Under a trade agreement framework, it is also interesting to determine the mechanisms or conditions to which local economies tend to respond, not only for theoretical purposes but for policy matters as well. Therefore, I explore two sources of heterogeneity: credit access and market access. Credit access is defined as the aggregate value of credits granted to small, medium, and large producers in a municipality. Market access consists of two proxies: the first is a domestic market proximity taken as the distance in kilometers to the nearest agricultural market, and the second one reflects proximity to the South Korean market, measured as the Euclidean distance from the centroid of each municipality to the port of Buenaventura. In addition, I use the median to classify municipalities with higher (above) and lower (below) credit and market access. For this heterogeneity research, I use the synthetic diff-in-diff method as the preferred specification since, by construction, it better adjusts for pre-treatment trends.

Table 7 presents group regression comparing treatment and control municipalities within

each classification level. Each row displays a different regression. Regarding credit access, the literature has shown that access to credit improves farm performance in terms of production and productivity (Haryanto et al., 2023; Hartarska et al., 2015). Column (1) shows that exposed municipalities with more credit tend to produce more, having the same differential increase as the aggregated effect identified in Table 6; accompanied by an expansion of planted area relative to less exposed municipalities. Moreover, column (3) shows that most connected municipalities to local agricultural markets absorb the effect on agricultural supply, particularly the increase in production is 142% higher than the general case, which is consistent with the literature of market access and economic advantages (Donaldson & Hornbeck, 2016; Storeygard, 2016). Higher connectivity also drives lower crop diversification, but no effects on land utilization. In contrast, column (6) shows that the most exposed municipalities farther away from the port of Buenaventura had a differential change in agricultural production and crop diversification, while there is no effect for those closest to the port. It seems to be a counterintuitive result since the distance to the port is expected to be positively correlated with transportation costs. However, since it is calculated by the Euclidean distance, it does not take into account the type or the quality of the roads. Therefore, the measure might be capturing other dynamics that do not necessarily depend on transportation costs.

Table 7: Heterogeneous effects

| | Credit access | | Domestic market proximity | | South Korean market proximity | |
|----------------|----------------------|-------------------|---------------------------|-------------------|-------------------------------|----------------------|
| | Above median | Below median | Above median | Below median | Above median | Below median |
| | (1) | (2) | (3) | (4) | (5) | (6) |
| Agric Output | 0.073** (0.033) | 0.066 (0.048) | 0.102** (0.041) | 0.035 (0.044) | -0.030 (0.047) | 0.088* (0.050) |
| Crop Div | -0.024*** (0.008) | -0.047 (0.041) | -0.015** (0.008) | -0.011 (0.007) | -0.001 (0.008) | -0.029*** (0.007) |
| Planted Area | 0.056** (0.022) | 0.016 (0.012) | 0.033 (0.033) | 0.009 (0.037) | -0.008 (0.034) | 0.038 (0.031) |
| Munis Analyzed | 543 | 525 | 539 | 529 | 546 | 522 |
| Treated Munis | 238 | 293 | 203 | 328 | 187 | 344 |

Notes: This table reports the Average Treatment Effect on the most exposed municipalities under the synthetic diff-in-diff approach. All dependent variables except for Cop Div are in logarithmic units. Standard errors are calculated by bootstrap and clustered at the municipality level. All regressions include pre-FTA covariates. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

Finally, as an additional exercise, I explore the differential response of municipalities intensive in coffee crops, which is a traditional export to South Korea, even before the FTA implementation. Table A.3 depicts no differential effect on agricultural production, which

is expected as its pre-tariff rate was already low (approximately 5%), meaning that the additional benefits of the FTA are not exclusively concentrated in coffee sales.

5.5 Robustness Checks

There is a remaining concern that the results can be highly sensitive to the cutoff upon which the treated municipalities are defined. In that regard, Table 8 shows that results on agricultural supply and economic growth proxies tend to be stable across different percentiles of treatment assignment. It is particularly interesting to highlight that when the cutoff increases, the effect on agricultural production is higher. This makes sense because municipalities facing higher tariff reductions are expected to experience even a more pronounced reaction.

Table 8: Different cutoffs of the exposure measure

| Outcome | Agric Output (1) | Crop Div (2) | Planted Area (3) | Value Added (4) | Night-time Lights (5) |
|----------------|---------------------|----------------------|---------------------|--------------------|--------------------------|
| Cutoff 50 | 0.072** (0.036) | -0.016*** (0.006) | 0.030 (0.022) | -0.004 (0.024) | 0.019*** (0.007) |
| Cutoff 60 | 0.095*** (0.035) | -0.009** (0.004) | 0.033 (0.030) | -0.007 (0.027) | 0.019** (0.008) |
| Cutoff 70 | 0.135*** (0.037) | -0.011* (0.006) | 0.052 (0.032) | -0.009 (0.027) | 0.026*** (0.009) |
| Cutoff 80 | 0.143*** (0.044) | -0.003 (0.006) | 0.068* (0.035) | -0.016 (0.035) | 0.029*** (0.008) |
| Cutoff 90 | 0.178*** (0.058) | -0.015* (0.009) | 0.119*** (0.046) | 0.059 (0.051) | 0.020* (0.010) |
| Munis Analyzed | 1068 | 1068 | 1068 | 1068 | 1068 |

Notes: This table reports the Average Treatment Effect on the most exposed municipalities as defined by different thresholds of the equation 1 above which treatment is defined. Dependent variables of columns (1), (3), (4), (5) are in logarithmic units. Standard errors are calculated by bootstrap and clustered at the municipality level. All regressions include pre-FTA covariates. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

6 Policy Implications

Trade agreements remain attractive tools for policymakers to promote economic growth and exploit productive advantages. Currently, Colombia holds 17 regional or bilateral agree-

ments (Procolombia, 2020), showing a governmental commitment to international partnership. In this scenario, tariff elimination and flexibility of non-tariff barriers are the main mechanisms of trade liberalization. Nevertheless, these instruments must be complemented by local policies to enforce the capacities of producers and truly take advantage of a favorable trade environment, otherwise, there is no effective liberalization.

The heterogeneous analysis shows that connectivity and credit access still play an important role in determining who reacts to international trade incentives. In that regard, technical guidance on export and productive vocation should be implemented to exploit opportunities in the Korean market. Studies regarding international trade effects mainly focus on large partners, such as the United States, China, and the European Union, however, there is less attention to non-traditional partners. Even though agricultural exports to South Korea have traditionally represented less than 2% of total exports, specific products such as exotic fruits could eventually consolidate a share market in South Korea if efforts and investment go in that direction.

7 Conclusions

The FTA of Colombia with South Korea provides an interesting case study for understanding the effects of bilateral trade agreements on the local economies of developing countries. The extensive literature has addressed the potential distortions in domestic markets caused by competition from foreign goods that benefit from tariff reductions. However, less attention has been given to the perspective of the exporting country when such agreements improve access to previously closed markets. Focusing on this perspective allows for broadening the analytical lens on episodes of economic liberalization and to assess the assumptions of classical trade theory (ie. Heckscher-Ohlin model, Ricardian comparative advantage model).

Following standard methodological approaches in the literature, this study uses a trade exposure measure consisting of tariff reductions and pre-FTA production structures to determine the degree of openness each municipality faces regarding the crops under analysis. This approach enables to design a difference-in-differences model to estimate the causal effect of the FTA on the municipalities with higher exposure levels.

In summary, the results show a differential growth of agricultural production in the most exposed municipalities and higher crop concentration. It is worth noting that a systematic

decline in crop diversification does not imply export diversification, but a signal that local economies tend to adjust to future FTA tariff reductions. In addition, higher production does not necessarily translate to gains in welfare. There is no clear evidence of higher economic performance, even though there seems to be a higher night-time light intensity after controlling for pre-treatment differences between municipalities with high and low levels of exposure; the value added coefficient does not back up the conclusions regarding short-term economic growth. However, these estimates must be interpreted with caution, the primary sector value-added not only covers agricultural activities, but livestock and mining as well, suggesting that null effects do not necessarily mean a lack of economic growth, but that the empirical model fails to detect them. Another limitation of the methodology is the conception of trade exposure, this study accounts for a potential level given by pre-treatment relative importance of each crop, but omits other factors such as exporting vocation on the liberalized products and export experience that might be relevant in determining effective exposure.

Furthermore, the relevance of the findings lies in identifying the limitations of how these can be interpreted under the comparative advantage theory. Even though local production appears to move towards the products subject to the FTA, nothing can be said regarding the factor mobility. The scope of the empirical model does not allow for determining whether agricultural employment increased in the first 7 years of the agreements in the most exposed municipalities. Nothing can be said about equilibrium effects or structural changes due to the locality and short-term nature of the analysis. Accordingly, further research should focus on agricultural labor market outcomes under a bilateral trade framework to understand the true opportunities, long-term welfare effects, and even unexpected consequences resulting from embracing a free trade agreement with a non-traditional trade partner that does not represent a competitive threat to local agricultural production.

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Appendix A: Additional Tables and Figures

Table A.1: Sample of liberalized products

| Crop | Initial Tariff | Tariff Reduction | Timeframe for the elimination |
|---------------|----------------|------------------|-------------------------------|
| Cassava | 45 | 33.75 | 5 |
| Watermelon | 45 | 28.16 | 7 |
| Strawberry | 45 | 28.16 | 7 |
| Tomato | 45 | 28.16 | 7 |
| Blueberry | 45 | 28.16 | 7 |
| Guava | 30 | 22.5 | 5 |
| Avocado | 30 | 22.5 | 5 |
| Date | 30 | 22.5 | 5 |
| Banana | 30 | 22.5 | 5 |
| Taro | 30 | 22.5 | 5 |
| Melon | 30 | 22.5 | 5 |
| Sweet potato | 30 | 22.5 | 5 |
| Carnation | 25 | 21.88 | 3 |
| Papaya | 30 | 18.78 | 7 |
| Mangosteen | 30 | 18.78 | 7 |
| Corn | 30 | 18.78 | 7 |
| Mango | 30 | 18.78 | 7 |
| Pineapple | 30 | 18.78 | 7 |
| Chrysanthemum | 25 | 18.75 | 5 |
| Rose | 25 | 18.75 | 5 |
| Palm oil | 8 | 6 | 5 |
| Coffee | 4.6 | 4.6 | 0 |
| Soy | 3 | 3 | 0 |

Notes: This table reports the average tariff reduction in percentage points for 23 of the most representative crops in Colombian agricultural production that completed liberalization in the 2016-2022 period.

Table A.2: Differential export increase

| | (1) | (2) |
|-----------------------|--------------------|---------------------|
| $Kor_d \times post_t$ | 1.829** (0.773) | 1.829*** (0.656) |
| Obs | 180 | 180 |
| $R^2.Adjust$ | 0.01 | 0.49 |
| Fixed effects | No | Yes |

Notes: Using the export microdata from DANE, I estimate the following difference in differences type regression: $\log(exports)_{dt} = \alpha_d + \alpha_t + \beta Kor_d \times post_t + \varepsilon_{dt}$. Kor_d identifies exports to South Korea and $post_t$ refers to years after 2015. β captures the differential increase of exports to South Korea after the FTA implementation. The regression considers the following group of Colombian trade partners: United States, China, Chile, Japan, Argentina, Brasil, Ecuador, India, Israel, Netherlands, Panama, Peru, Turkey and Venezuela. Robust standard errors. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

Table A.3: Heterogeneous effects by coffee specialization

| | Above median (1) | Below median (2) |
|----------------|---------------------|---------------------|
| Agric Output | -0.014 (0.023) | -0.045 (0.058) |
| Crop Div | -0.066* (0.035) | -0.012 (0.008) |
| Planted Area | -0.001 (0.013) | -0.035 (0.046) |
| Munis Analyzed | 327 | 325 |
| Treated Munis | 88 | 176 |

Notes: This table reports the Average Treatment Effect on the most exposed municipalities. All dependent variables except for Cop Div are in logarithmic units. Standard errors are calculated by bootstrap and clustered at the municipality level. All regressions include pre-FTA covariates. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

Table A.4: Normalized crop diversification

| | (1) | (2) | (3) |
|---------------------------------|-------------------|-------------------|---------------------|
| Treated × After CKFTA | -0.010 (0.007) | | |
| Weighted tariff × After CKFTA | | -0.001 (0.001) | |
| Treated × Between 2016 and 2018 | | | -0.003 (0.006) |
| Treated × After 2019 | | | -0.018** (0.008) |
| Obs | 11727 | 11727 | 11727 |

Notes: This regression table shows the results for the normalized crop diversification index using the canonical diff-in-diff specification. Standard errors clustered at the municipality. All regressions include pre-FTA controls. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

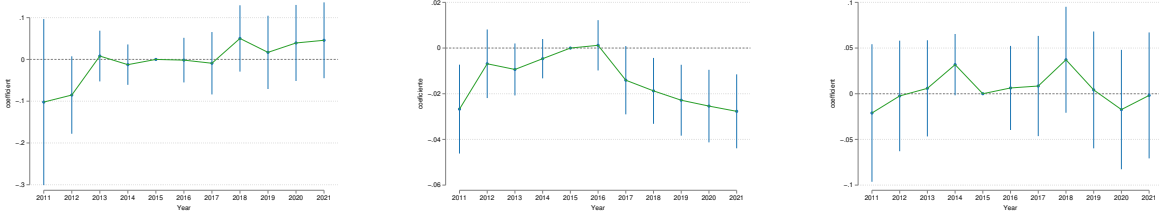
Table A.5: Event Study estimates with the Synthetic diff-in-diff

| Outcome | Agric Output | Crop Div | Night-time Lights |
|----------------|---------------------|----------------------|--------------------|
| | (1) | (2) | (3) |
| Effect 2016 | 0.040 (0.031) | 0.002 (0.005) | 0.011* (0.007) |
| Effect 2017 | 0.049 (0.032) | -0.013** (0.005) | 0.015 (0.009) |
| Effect 2018 | 0.041 (0.040) | -0.019*** (0.007) | 0.042** (0.018) |
| Effect 2019 | 0.062 (0.044) | -0.019*** (0.007) | 0.016* (0.009) |
| Effect 2020 | 0.117** (0.047) | -0.021*** (0.008) | 0.010 (0.009) |
| Effect 2021 | 0.125*** (0.049) | -0.026*** (0.008) | 0.019** (0.009) |
| Munis Analyzed | 1068 | 1068 | 1068 |
| Treated Munis | 531 | 531 | 531 |

Notes: This table reports the dynamic effects in the post-FTA period. Dependent variables of columns

(1) and (3) are in logarithmic units. Standard errors are calculated by bootstrap and clustered at the municipality level. All regressions include pre-FTA covariates. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

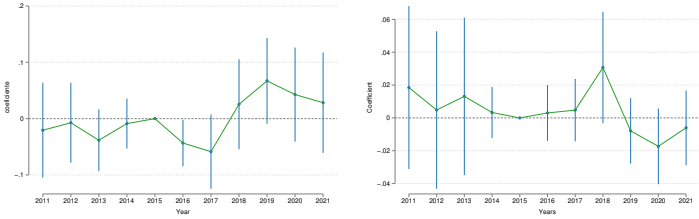
Figure A.1: Event Studies



(a) Agricultural Output

(b) Crop Diversification

(c) Planted Area

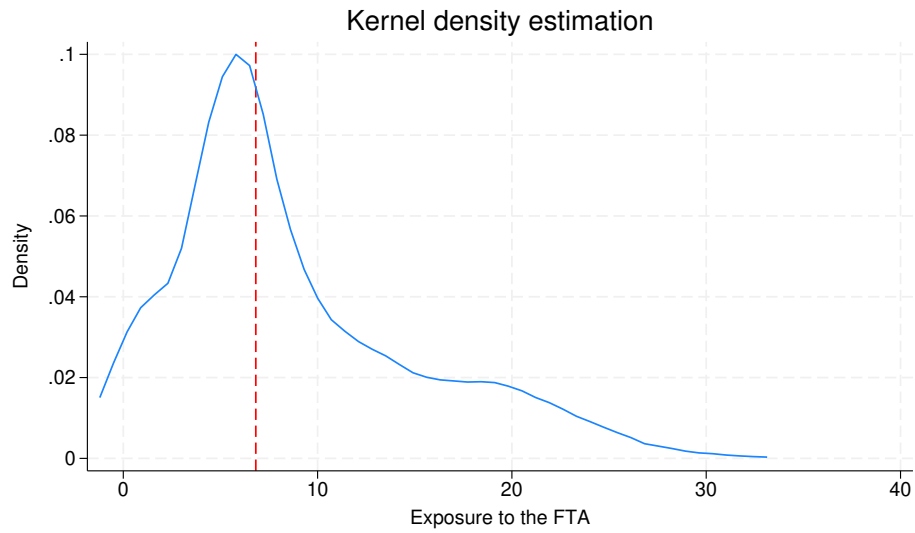


(d) Value Added

(e) Night-time Lights

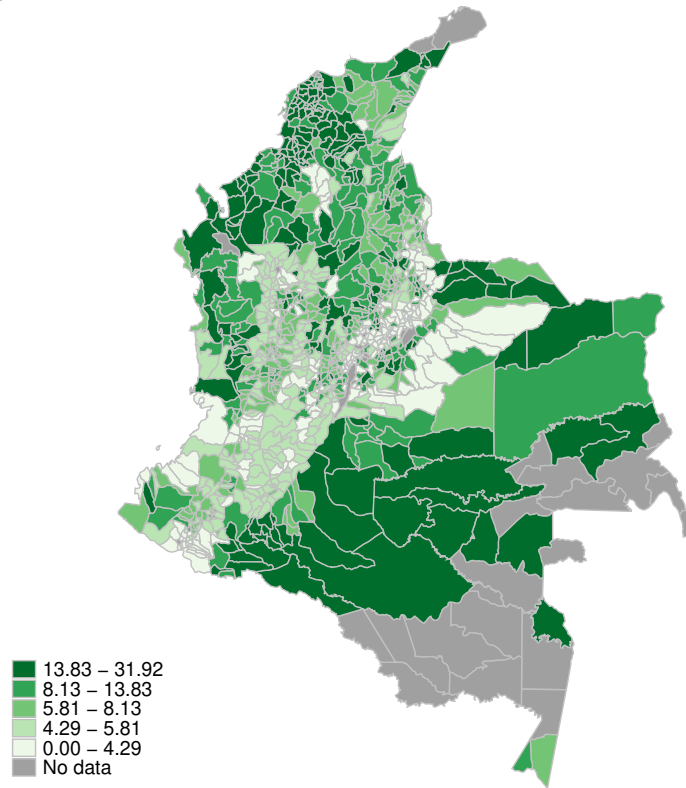
Notes: These figures allude to the event study of the canonical diff-in-diff approach given by the equation 5. The segment containing the point estimate corresponds to the 95% confidence interval.

Figure A.2: Exposure measure distribution



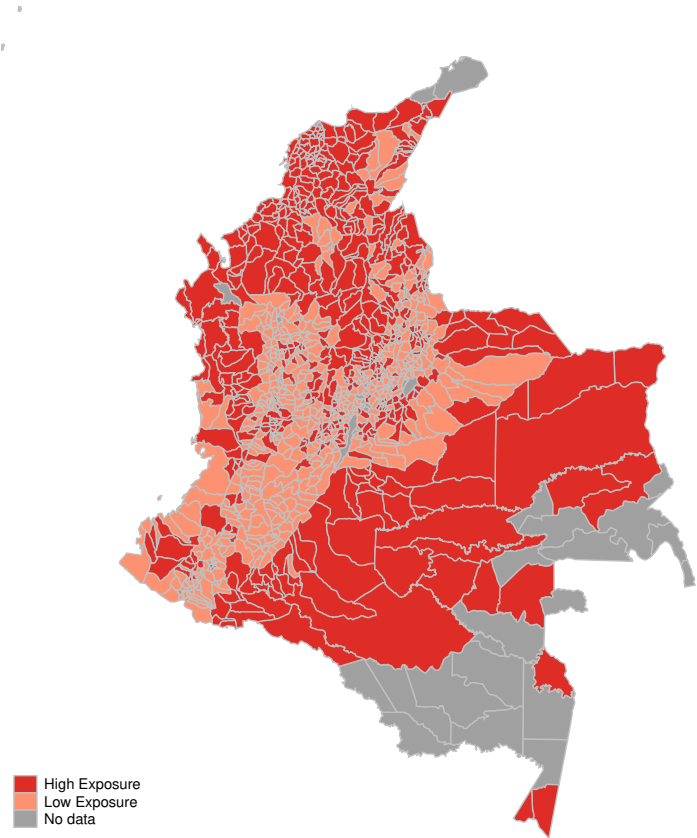
Notes: This figure alludes to the empirical distribution of the exposure measure. The red line refers to the median of the distribution, which is 6.82 percentage points.

Figure A.3: Geographical distribution of exposure intensity



Notes: This figure alludes to the geographical distribution of the weighted average tariff reduction.

Figure A.4: Most vs Least exposed municipalities



Notes: This figure shows the geographical distribution of the most exposed municipalities due to the nominal tariff reduction 2016-2022.

Figure A.5: Evolution of agricultural exports to South Korea

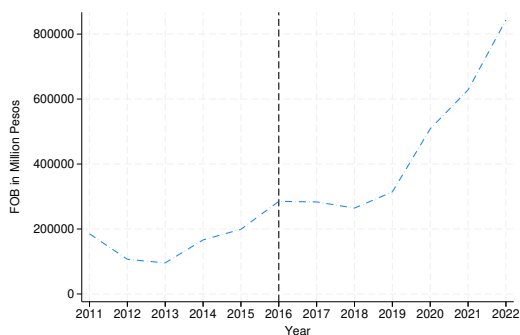


Figure A.5.a. Nominal value

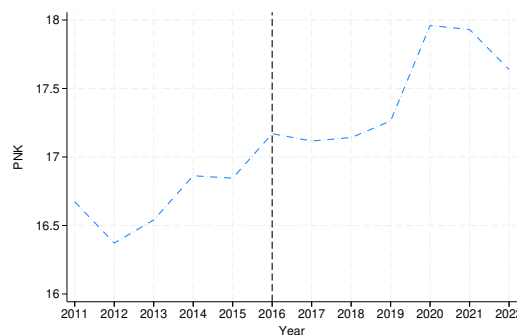


Figure A.5.b. Exported volume

Notes: Figure A.5.a shows the evolution of the FOB value exports in million pesos. Figure A.5.b shows the net weight in kilos of exported products as a volume proxy; the time series is in logarithmic units.

Figure A.6: Agricultural production vs Value Added

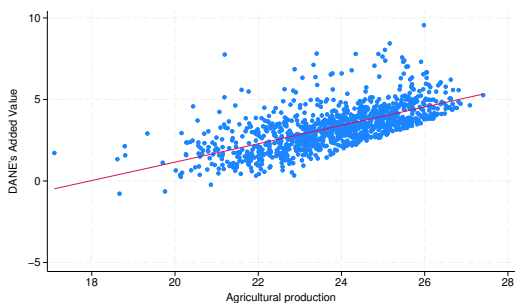


Figure A.6.a. 2014 correlation

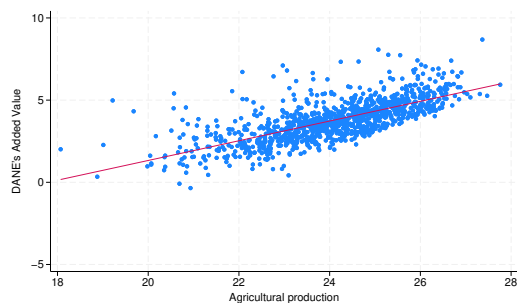
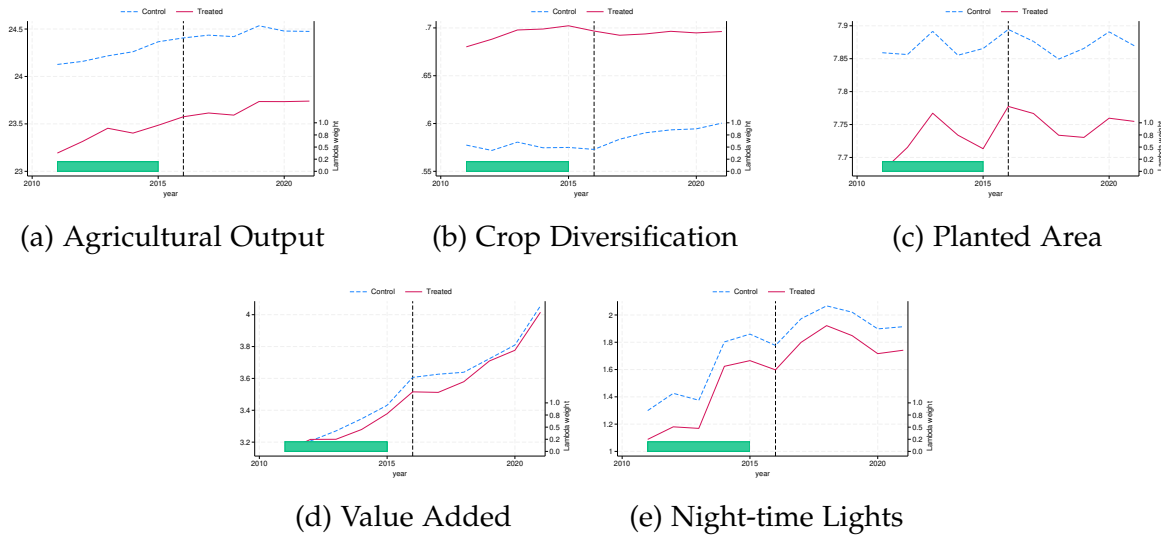


Figure A.6.b. 2020 correlation

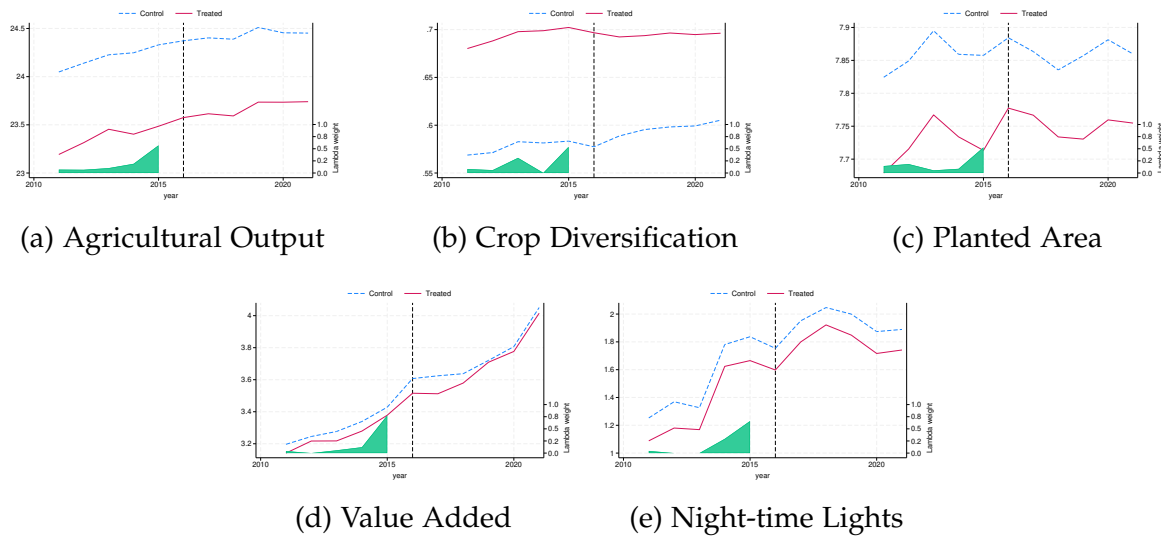
Notes: Linear correlation between agricultural production from the *Evaluaciones Agropecuarias Municipales* and the municipal value-added estimated by DANE in two different years. Both variables are in logarithmic units. The regression yields a statistically significant coefficient of 0.547 at the 1% level, with R^2 of 0.41. When controlling for municipality and year fixed effects, the regression yields a coefficient of 0.238, remaining significant and with R^2 of 0.92

Figure A.7: Time series of main outcomes under Standard Diff-in-Diff



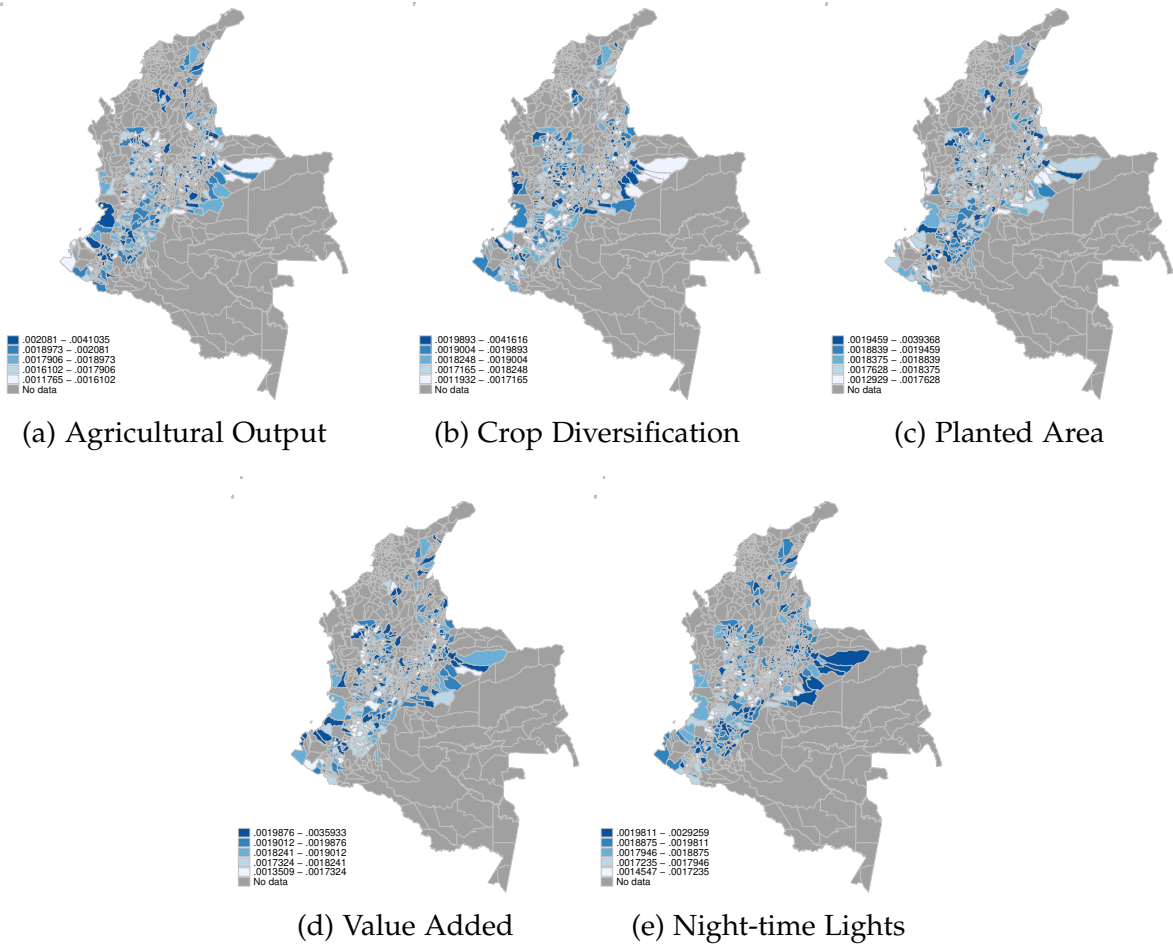
Notes: These figures display the time series of both the control and treatment groups derived from the standard diff-in-diff approach.

Figure A.8: Time series of main outcomes



Notes: These figures display the weighted time series of both control and treatment groups from the synthetic diff-in-diff approach by Arkhangelsky et al. (2021).

Figure A.9: SDID Weights



Notes: These figures show the unit-specific weights for the control municipalities under the synthetic diff-in-diff approach shown in Table 6.